

**RESPONSES TO
USEPA COMMENTS ON THE SECOND OPERABLE UNIT
REMEDIAL INVESTIGATION REPORT
SYOSSET LANDFILL, SYOSSET, NEW YORK**

RESPONSES TO GENERAL COMMENTS

1. • The background information that was provided in the First Operable Unit (OU-1) Remedial Investigation (RI) report will be included, along with the tables, figures, and appendices referenced in those sections, as an addendum in the revised Second Operable Unit (OU-2) RI report.
- The thickness and depth data for the three geologic formations underlying the site is as follows and will be included in the revised OU-2 RI report. The upper 60 to 100 feet of unconsolidated sand and gravel deposits in the vicinity of the landfill comprises the Upper Glacial Formation. Before landfilling began, up to 90 feet of this formation was removed during sand mining at the site. The Magothy Formation, which is comprised of finer sands, silts and clays directly underlies the Upper Glacial Formation and is in hydraulic connection with it. This formation (Magothy) was not fully penetrated during either the OU-1 or OU-2 RIs. However, based on published data, the Magothy Formation is approximately 540 feet thick beneath the site and may extend as deep as 630 feet below landsurface. The Raritan Formation is the third, and deepest unconsolidated formation beneath the site and rests on the bedrock surface. Comprising this formation is the Raritan Clay Member, which is approximately 160 feet thick and occurs directly beneath the Magothy, and the Lloyd Sand Member, which is approximately 240 feet thick and rests on the bedrock surface more than 1,000 feet below land surface.
- 2a. • A discussion on regional background groundwater quality as it relates to groundwater quality in the area of the Syosset Landfill (on- and off-site), is provided in Attachment A, which will be included in the revised OU-2 RI report.

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- Naturally occurring high concentrations of iron is a common regional problem on Long Island. In Nassau County, 28 percent of the public supply wells (82 percent of which are screened in the Magothy aquifer) had concentrations exceeding the maximum contaminant level (MCL) of 300 ug/L for this metal (Proceedings 1993). During the OU-2 RI, 11 of the 24 monitoring wells sampled (41 percent) contained dissolved iron at concentrations exceeding the MCL. Ten of these eleven wells are located on-site (8 shallow wells and 2 shallow "intermediate" wells), and only one of these wells (shallow) is located off-site. The high iron concentrations in the groundwater on Long Island is discussed in greater detail in a 1993 Nassau County Health Department report entitled "The Groundwater and Public Water Supply Facts," which has been ordered from the department. Once Geraghty & Miller receives this document, the data will be evaluated and compiled as appropriate for inclusion in the revised OU-2 RI report.
- 2b. • A section on the processes concerning the fate and transport of contaminants is provided in Attachment B which will be included in the revised OU-2 RI report.
3. • An evaluation of the analytical results with respect to recharge basins adjoining the landfill and/or downgradient of the landfill is provided in Attachment C (Potential Impacts from Recharge Basins).
- A discussion of the potential impacts to the public supply wells in the vicinity of the landfill is provided in a new section entitled "Fate and Transport of Contaminants" (Attachment B) that will be included in the revised OU-2 RI report.
4. • Geraghty & Miller has reevaluated the logs and soil sampling data and has determined that the interpretation of the presence of "low-permeability" layers is valid and consistent. This interpretation is based on the patterns of gamma log responses, and the thicknesses and elevations of the various "low permeability" units identified. However, interpretation of gamma logs is somewhat subjective, especially with regard to the continuity of clayey units in the Magothy and, notwithstanding Geraghty & Miller's



professional judgement regarding this interpretation, references to the "low-permeability" layers will be deleted in the revised OU-2 RI report. The text and figures will also be modified to reflect this change and the description of the Magothy Formation will be more consistent with published documents. Specifically, the Magothy Formation will be described as consisting primarily of sand and silt with clay stringers and lenses.

5.
 - See the response to General Comment No. 4.
 - References to "low-permeability" units will be deleted in the revised OU-2 RI report.
6.
 - Three zones were conceptualized for the OU-2 RI based on the limited data available. The on-site intermediate wells are screened at higher elevations than the off-site intermediate wells. Geraghty & Miller made best use of these limited data in a manner that was consistent with the groundwater flow vectors and the hydrogeology and provided the best scenario for evaluating site conditions. The rationale for this conceptualization of zones is explained on page 3-5 in the OU-2 RI report. A stricter conceptualization of hydrogeologic zones would not be practical given the limited number of data points. Also in this regard, see the response to General Comment No. 4.
7.
 - The extent of contamination resulting from this site has not been clearly defined due to the limited number of data points. For the OU-2 RI drilling program, Geraghty & Miller used the only three accessible off-site locations: none other were available. The rest of the area downgradient of the site is a residential development extending well beyond Jericho Turnpike, located approximately 1 mile away. Furthermore, a clear delineation of landfill impacts on groundwater quality is difficult due to the substantially higher VOC concentrations in Well RW-12I than any other well on-site, the location of Well Cluster RW-12 proximate to a limiting groundwater flow line from the landfill,



and the regional degradation of groundwater quality (see the response to General Comment No. 2a). Therefore, it is necessary to investigate potential off-site contaminate source areas (see the response to General Comment No. 2a).

8. • The contaminants of concern, which are defined as those analytical parameters exceeding either the federal or state MCL, are provided in Attachment D. Remedial actions, objectives, and goals will be discussed in a future Feasibility Study report.

ACTION ITEMS

- 9a. • During and following the OU-1 RI, water levels were measured in the site monitoring wells on a monthly basis for more than 2 years. Invariably, the direction of groundwater flow was generally in a northerly direction during this time period. This flow direction is also consistent with the position of the regional groundwater divide south of the site, which has been consistently confirmed by the water-level data collected from Nassau County monitoring wells on four occasions over a 1-year period during and following the OU-1 RI and once during the OU-2 RI. In addition, water-levels collected from site monitoring wells during the OU-2 RI (October and November 1993) reconfirm the understanding of groundwater flow directions developed from this water-level monitoring that took place during the OU-1 RI. Therefore, we do not see a need to collect additional water-level data.
- 9b. • Geraghty & Miller is currently conducting a survey of the LIRR and industrial/commercial properties west of the LIRR tracks near and upgradient of Well Cluster RW-12 to identify potential off-site contaminant source areas. This survey will include site reconnaissance; accessing various databases such as those for the Comprehensive Environmental Response Compensation and Liability Act, the Resource Conservation and Recovery Act, the National Priorities List, and oil/chemical spills for possible listings of sites; review of Sanborn maps (if possible) and historical aerial photographs; chain-of-title searches; and accessing files at local government agencies.



RESPONSES TO SPECIFIC COMMENTS

1.
 - See the response to General Comment No. 4. References to "low-permeability" layers will be deleted in the revised OU-2 RI.
 - The statement that "the deepest low-permeability unit appears to have prevented the movement of contaminants into the deep zone except at "off-site Well RW-12D" will be deleted.
2.
 - See the response to General Comment No. 2a. Additional information on regional background water quality is provided in Attachment A.
3.
 - No added value will be gained by providing additional information on recharge basins. Effects on groundwater flow directions or groundwater quality that could be attributed to the recharge basins were not observed. See Attachment C for more details.
 - As mentioned in the response to General Comment No. 9a, as part of the OU-1 RI, water levels were measured in the site monitoring wells for more than 2 years. During this time period, and for the two rounds of water levels collected during the OU-2 RI, the groundwater flow was consistently observed to be in the same direction (northerly). This flow direction is also consistent with the position of the regional groundwater divide south of the site, which has been consistently confirmed by the water-level data collected from Nassau County monitoring wells on four occasions over a 1-year period during and following the OU-1 RI and once during the OU-2 RI. In addition, the horizontal hydraulic gradients observed during these two studies (RIs) were uniformly relatively flat, and the vertical hydraulic gradients were virtually always downward and more pronounced than the horizontal hydraulic gradient. Thus, the northerly groundwater flow directions, relatively flat horizontal hydraulic gradients, and the pronounced downward vertical hydraulic gradients observed during the OU-1 RI and OU-2 RI is consistent with the position of the regional groundwater divide south of the



landfill. Significant mounding of the water table due to infiltration of stormwater from the basins has never been observed during the OU-1 and OU-2 RIs. Based on this discussion, no significant impacts to the groundwater flow system are evident from the recharge basins near the landfill.

4. • An explanation of how the gamma logs for Wells SY-3DD and PK-10D were corrected for casing interferences is provided in Attachment E.
5. • Because all of the data contained in Table 2-4 in the OU-2 RI report applies to Nassau County monitoring wells that are screened within 50 feet of the water table, water-level elevation data from these county monitoring wells were used to construct a regional potentiometric surface map of the shallow zone (Figure 3-3 in the OU-2 RI report). Well construction details, including the depths of the zones monitored by the regional wells relative to the water table is provided in the revised Table 2-4 (Attachment F).
 - An 82-foot contour line on Figure 3-3 was not placed around Nassau County Monitoring Well PT-1A because there was no control for drawing this contour. Furthermore, inclusion of the 82-foot contour on the figure would not provide additional knowledge of the groundwater flow direction.
6. • Figure 8 from the OU-1 RI report will be provided in the revised OU-2 RI report as part of the addendum.
7. • The construction of Figures 3-3, 3-4, and 3-5 is based on Geraghty & Miller's interpretation of the data and our professional judgement. These figures will not be modified, nor will we speculate on how else the maps may be drawn. During the OU-1 RI, Geraghty & Miller measured water levels in the regional Nassau County monitoring wells on four different occasions over a 1-year period. On none of these occasions was the regional groundwater divide observed to have shifted: the regional flow maps developed from these data were strikingly similar and unchanging. This



observation is also consistent with published maps that Geraghty & Miller examined during preparation of the OU-1 RI, and the divide has been shown to be south of the site on all of these maps. In addition, water levels were measured in the site monitoring wells on a monthly basis for more than 2 years. Groundwater flow directions were consistently observed to be in a northerly direction, verifying the position of the regional groundwater divide south of the landfill. The groundwater divide is too far from the shore to be affected by tidal fluctuations. Speculative discussions on how the divide may shift are inappropriate when there are data available over a period of time that show a consistent orientation and position of the divide.

8. • Because the description of the Magothy Formation will be modified to be more consistent with published data and with no reference to "low-permeability" layers in the revised OU-2 RI report, comparisons of water-quality data from wells screened at different levels within the intermediate zone of the Magothy aquifer can be made (see the response to General Comment No. 4).
9. • The values used for "L" in the calculation of hydraulic gradients are provided in Table 3-1 (Attachment G) which will be included in the revised OU-2 RI report.
10. • The horizontal hydraulic gradient data are provided in Table 3-1 (Attachment G). Average horizontal hydraulic gradients are also provided in this table. The values of horizontal hydraulic gradients presented in this table vary slightly, but not significantly, from the values originally presented in the OU-2 RI report. These new values will be presented in the revised OU-2 RI report.
11. • The vertical hydraulic gradient data is provided in Table 3-1. The distance (L) between the screen zones is provided in this table.
12. • The following discussion of the detections of volatile organic compounds (VOCs) with respect to federal and state MCLs will be provided in the revised OU-2 RI report and



MCLs will also be included in the revised Table 3-3 (previously Table 3-2). In the on-site wells, MCLs were exceeded for the following nine compounds: vinyl chloride, cis-1,2-dichloroethene, chloroform, benzene, toluene, tetrachloroethene, 2-hexanone, chlorobenzene, and ortho-xylene. Of the thirteen on-site wells sampled, at least one VOC was detected in seven wells (SY-1D, SY-3, SY-3D, SY-4, SY-6D, SY-7, and SY-8) above the federal and/or state MCLs during one or both sampling rounds. Well SY-7 contained four compounds (benzene, toluene, 2-hexanone, and ortho-xylene) which exceeded the federal and/or state MCLs. The remaining six wells contained only one or two compounds which exceeded one or both of the MCLs. The VOC concentrations detected in on-site monitoring wells during the OU-21 RI are consistent with regionally degraded groundwater quality as discussed in Attachment A.

- In the off-site wells, the MCLs were exceeded for the following ten compounds: vinyl chloride, 1,1-dichloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, benzene, trichloroethene, toluene, tetrachloroethene, and chlorobenzene. Of the eight off-site wells sampled VOCs were detected in six of these wells above the federal and/or state MCLs in one or both sampling rounds. Well RW-12I contained the most (seven) compounds (1,1-dichloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, toluene, and tetrachloroethene) which exceeded federal and/or state MCLs. Well RW-12D had three compounds (vinyl chloride, benzene, and toluene) which exceeded the MCLs. The remaining four off-site wells contained only one or two compounds which exceeded one or both of the MCLs. The VOC concentrations detected in off-site monitoring wells (except Well RW-12I) during the OU-21 RI are consistent with regionally degraded groundwater quality as discussed in Attachment A.

13. • The statement in the OU-2 RI report, "it appears that a source other than the landfill may exist" is based on the limited data that was evaluated, and the reasons for making this statement were clearly given. As discussed in the response to General Comment



No. 9b, a survey of industrial/commercial properties will be conducted west of the LIRR tracks to identify potential off-site contaminant source areas.

14. • The analytical results for metals were not presented on figures in the OU-2 RI report because these parameters were not detected at elevated concentrations at off-site wells, therefore, these parameters are not of concern and it is unnecessary to plot these data on maps.
15. • The following statement of the distribution of metals in the shallow zone will be added to Section 3.3.1 of the revised OU-2 RI report. There does not appear to be any particular distribution of metals relative to the western or eastern portions of the landfill as there were for VOCs and leachate indicator parameters.
 - Except for cadmium, iron, lead, nickel, potassium, and zinc, the metal concentrations were lower in the shallow off-site wells than in the shallow on-site wells. Cadmium, iron, lead, nickel, potassium, and zinc were generally lower in the shallow off-site wells than in the shallow on-site wells.
16. • The concentrations of iron, sodium, and potassium detected in site monitoring wells during the OU-1 and OU-2 RIs were compared to data collected from the following two USGS reports, which provide some information on the background concentrations of these metals: (1) Geology and Hydrology of Northeastern Nassau County, Long Island, New York (1966), and (2) Hydrology and Ground-Water Quality of the Northern Part of the Town of Oyster Bay, Nassau County, New York, in 1980 (1987). For the 223 groundwater samples analyzed during the first USGS study, the range in iron concentrations for the Magothy aquifer was 0 ug/L to 1,200 ug/L and the median concentration was 40 ug/L. Although approximately five times as many samples were analyzed (1,155) during the second USGS study, the median iron concentration was the same as the first study (40 ug/L), but the maximum iron concentration was about an order of magnitude higher (15,800 ug/L). During the OU-2 RI, iron concentrations



exceeded the MCL (300 ug/L) in 15 wells and exceeded the USGS-determined median value in all but two of the 21 wells sampled. The concentrations of iron sometimes exceeded the maximum value reported by the USGS (1987) in on-site wells. Thus, the iron concentrations observed during the OU-2 RI exceeded background concentrations for this metal in most of the monitoring wells and are likely landfill derived.

In the first USGS report (1966), the analytical results for sodium and potassium were reported as composite values for the 35 groundwater samples that were collected during this study from wells screened in the Magothy aquifer. The range of the combined concentrations of these two metals was 1,200 ug/L to 9,600 ug/L with a median combined concentration of 4,800 ug/L. The potassium concentrations detected during the OU-2 RI exceeded the median combined concentrations of sodium and potassium in seven on-site and two off-site monitoring wells (shallow and intermediate zones only). Thus, the potassium concentrations detected during the OU-2 RI are elevated and are also likely to be landfill derived.

During the second USGS study (1987), 732 samples from 69 wells screened in the Magothy aquifer were analyzed for sodium (potassium was not analyzed in this study). The range of concentrations for sodium in the 1987 study was 0 ug/L to 90,000 ug/L, with a median concentration of 6,000 ug/L. During the OU-2 RI, sodium concentrations exceeded the median value in 20 of the 21 wells sampled (except Well RW-11D) and, except for three of these wells (RB-11S, RB-11I, and RB-11D), which are located at a Recharge Basin (off-site), the MCL (20,000 ug/L) was also exceeded. Thus, the elevated sodium concentrations observed during the OU-2 RI are also likely to be landfill derived.

The background concentrations of iron, potassium, and sodium discussed above will be included in the appropriate sections of the revised OU-2 RI report.



17. • A statement was made in the first sentence of the second paragraph in Section 3.3.2 of the OU-2 RI report that the detected concentrations of VOCs were slightly higher in off-site intermediate wells than in on-site intermediate wells.
18. • The following discussion of the distribution of metals in the intermediate zone will be added to Section 3.3.2 in the revised OU-2 RI report. On-site, the following eleven metals were detected in one or more of the four intermediate wells: arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, potassium, sodium, and zinc. Barium, iron, lead, potassium, sodium, and zinc were detected in every intermediate on-site well. Because of the limited number of data points on-site, it is not possible to discern whether concentrations are substantially different on the eastern portion of the landfill as compared to the western part of the landfill.
 - Off-site, the following seven metals were detected in the three intermediate wells: barium, chromium, iron, lead, potassium, sodium, and zinc. In addition, cadmium was detected in Wells RB-11I and RW-12I, copper and nickel were detected in Wells PK-10I and RB-11I, and antimony and arsenic were only detected in Well RW-12I. In general, the concentrations of metals are similar in the intermediate on-site and off-site wells.
19. • The following discussion of the distribution of metals in the deep zone will be added to Section 3.3.3 in the revised OU-2 RI report. On-site, antimony, barium, chromium, copper, iron, lead, nickel, potassium, silver, sodium, and zinc were the only metals detected in the deep well (SY-3DD). Off-site, the following metals were detected in each of the three deep wells: barium, chromium, iron, lead, potassium, sodium, and zinc. In addition, arsenic and cadmium were detected in Well PK-10D, copper was detected in Wells RB-11D and RW-12D, and nickel was only detected in Well RB-11D. Because of the limited number of data points in the deep monitoring zone, it is not possible to discern whether concentrations are substantially different in the on-site well as compared to off-site wells.



20. • The following statement of the distribution of metals within the three zones will be added to Section 3.3.4 in the revised OU-2 RI report. Metal concentrations are similar in the shallow and intermediate zones (on-site and off-site) and are generally lower in the deep off-site wells.
21. • The following discussion of the migration of metals will be added to Section 3.4 in the revised OU-2 report.
- In the shallow zone, several metals were detected above their respective MCLs on-site in several wells. However, off-site the only metals detected above their respective MCLs were iron at concentrations of more than 680 ug/L (the MCL for iron is 300 ug/L) and sodium at concentrations of up to 20,900 ug/L (the MCL for sodium is 20,000 ug/L) in Well PK-10S. As mentioned above, this well is located directly downgradient of the area on-site with the highest leachate indicator concentrations.
 - In the intermediate zone, several metals were detected above their respective MCLs on-site, but, off-site, the only metal detected above its MCL was sodium in Well PK-10I (176,000 ug/L to 237,000 ug/L).
 - In the deep zone, the only on-site deep well (SY-3DD) had concentrations of iron /exceeding the MCL of 300 ug/L for both sampling rounds, but these exceedences apply only for the total analysis not the dissolved analysis. Antimony was also detected in Well SY-3DD above its MCL of 6 ug/L during the first sampling round (25 ug/L) for the total analysis only. Off-site, iron was detected above the MCL in Wells RB-11D (total analysis only for both sampling rounds [975 ug/L and 958 ug/L]) and RW-12D (total analysis only for the second sampling round [552 ug/L]). Sodium was the only other metal to be detected in the off-site deep wells above the MCL. This metal was detected above the MCL for the total and dissolved analyses in Wells PK-10D during the first sampling round at concentrations of up to 22,900 ug/L and RW-12D during



both sampling rounds at concentrations of up to 66,500 ug/L. Additional information regarding ambient concentrations of iron will be obtained from the NCDH document referenced earlier (see the response to General Comment No. 2).

22. • The MCL for 1,1-dichloroethane was exceeded in Well PK-10S during both sampling rounds. This statement will be included in the revised OU-2 RI report.
 - Similar concentrations of leachate parameters were detected in the on-site wells and the downgradient off-site wells, indicating a connection between the landfill contamination and off-site contamination. However, the concentrations of VOCs, which are also similar in on-site and downgradient (off-site) wells (except RW-12D), are also consistent with regional degraded background water quality that has been observed throughout Nassau County (see Attachment A).
23. • The MCLs of selected individual VOCs were exceeded during one or both groundwater sampling rounds in six of the eight off-site wells (PK-10S, PK-10I, PK-10D, RB-11I, and RW-12I) sampled. Except for Well RW-12I, these VOC concentrations are consistent with regionally degraded groundwater quality as discussed in Attachment A of this document.
24. • The VOC concentrations in Well RW-12I were several times higher than in any of the other wells (on-site or off-site) during either sampling round. Given the fact that Well RW-12I is located hydraulically downgradient of the western most edge of the landfill (i.e. near the western most limiting groundwater flow line), and adjacent to an industrial area located west of the LIRR tracks, the anomalously high concentrations of VOCs detected in this well may be derived from a source other than the landfill. The physical process that could explain how VOCs could impact Well RW-12I is hydrodynamic dispersion. Dispersion is the tendency of a solute or contaminant "to spread out from the path that it would be expected to follow according to the advective hydraulics of the flow system" (Freeze & Cherry 1979) and it is caused by the process of molecular



diffusion and mechanical mixing. Mechanical mixing (mechanical dispersion) is the dominant force behind dispersion. Diffusion generally plays a minor role and is only important when groundwater velocity is extremely slow (not the case at the Syosset Landfill) and is proportional to the concentration gradient, i.e., contaminants spread from areas of high concentrations to areas of lower or no concentration. Diffusion becomes more important with higher contaminant concentrations and can cause the spread of contaminants in all directions. Mechanical dispersion occurs in both the direction of bulk groundwater flow (longitudinal dispersion) and transverse to the direction of bulk flow (transverse dispersion). Dispersion is a microscopic phenomenon that results from the different velocities and tortuous path of groundwater flow within the pore spaces of the aquifer material. The process of dispersion is a mixing process that has a qualitatively similar effect to turbulence in surface water regimes (Freeze and Cherry 1979). Thus, it is possible for contaminants (i.e., VOCs) from near the edge of the landfill to spread laterally via transverse dispersion and impact Wells RW-12I and RW-12D. However, it is also possible that contaminants (i.e. VOCs) in Well RW-12I and RW-12D may be derived from a source other than the landfill by the same process. The data that will be obtained from the survey of industrial/commercial properties west of the LIRR tracks may help clarify this matter. The same rationale regarding limiting groundwater flow lines and dispersion discussed above generally applies to Well RB-11I, but this cluster is clearly outside the easternmost limiting groundwater flow line (by almost 400 feet) and contaminants detected in this well are even more likely to be derived from a source other than the landfill.

25. • The statement that Well RW-12I is close to, or possibly outside of, the westernmost limiting groundwater flow line was based on Geraghty & Miller's interpretation of the available data, and unless additional data are developed to show otherwise, this statement will remain in the revised OU-2 RI report. It was not stated in the OU-2 RI



report that the VOCs in Well RW-12I are from another source, rather, it was stated that they may be from another source. We agree that additional information (see response to Action Item 9b) is needed.

26. • The statement that Well RB-11I is outside the easternmost limiting groundwater flow line from the landfill was based on the depiction of the groundwater flow direction in the intermediate zone as presented in Figures 3-6 and 3-7. In fact, the groundwater flow line shown on these figures passes through Well Cluster SY-1 and represents the easternmost limiting groundwater flow line. Clearly then, Well Cluster RB-11 is more than 400 feet east of this flow line.
 - Well RB-11I was interpreted as being located outside the easternmost limiting groundwater flow line from the landfill based on water-level elevation data collected during the OU-2 RI. It is valid to compare data from this well to other off-site wells downgradient from the landfill. This comparison serves to illustrate the similarity in VOC concentrations of a well directly downgradient of the landfill, such as PK-10I, with the VOC concentrations of a well outside of the influence of the landfill (i.e. RB-11I) and also demonstrates the limited impact of the landfill on groundwater quality, particularly with respect to VOCs. Furthermore, this comparison reinforces and supports published data regarding the degraded regional condition of groundwater (see Attachment A).
27. • See response to Specific Comment No. 24.
28. • Reference to the "deepest continuous low permeability unit" will be deleted in the revised OU-2 RI report as explained in the response to General Comment No. 4.
29. • As discussed in the response to General Comment No. 4, all references to the lower permeability units identified in the OU-2 RI report will be deleted. The Magothy Formation will be described in a manner that is more consistent with published data.



- 30. • See the response to General Comment No. 2a.
 - The effects of dispersion on the spread of contaminants with respect to limiting groundwater flow lines was discussed in the response to Specific Comment No. 24.
 - See the response to Specific Comment No. 26.
- 31. • The hydrogeologic and analytical data presented in the report is sufficient to support the conclusion that VOC contamination detected in Well Cluster RW-12 may be derived from an off-site source. It was never stated definitively that VOCs in Well RW-12 I were derived from another source. Geraghty & Miller's survey of industrial/ commercial properties west of the LIRR will provide additional data in this regard.
- 32. • In addition to Well Cluster RW-12, Well Clusters PK-10 and RB-11 will be monitored.
- 33. • See the response to Specific Comment No. 7.
- 34. • See the response to Specific Comment No. 7.
- 35. • Chloroform (CF) will be added to the list of VOC contaminants on Figure 3-11.

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REFERENCE

- Freeze, R.A., and J.A. Cherry. 1979. Groundwater. Englewood Cliffs, New Jersey, Prentice Hall, pp. 604.
- Isbister, J. 1966. Geology and Hydrogeology of Northeastern Nassau County, Long Island, New York. U.S. Geological Survey Water-Supply Paper 1825, pp. 89.
- Kilburn, C. and R.K. Krulikas. 1987. Hydrogeology and Ground-Water quality of the Northern Part of the Town of Oyster Bay, Nassau County, New York, in 1980. U.S. Geological Survey Water-Resources Investigations Report 85-4051, pp. 61.



ATTACHMENT A
REGIONAL BACKGROUND GROUNDWATER QUALITY



ATTACHMENT A

REGIONAL BACKGROUND GROUNDWATER QUALITY

Groundwater is the sole source of drinking water on Long Island (Nassau and Suffolk Counties). As such, maintaining high quality drinking water is important. When volatile organic compounds, tetrachloroethylene (PCE) and trichloroethylene (TCE), were detected in supply wells in the southeastern part of Nassau County in 1975, the Nassau County Department of Health (NCDH) launched a series of investigations to evaluate regional groundwater quality conditions. One of these studies (Dvirka and Bartilucci Consulting Engineers 1986) was a preliminary investigation of five areas of aquifer segments contaminated with VOCs (New Cassel, Garden City Park, West Hicksville, New Hyde Park, and North Hicksville). During this study, a total of 96 wells were sampled, which included 18 public supply wells. Most of these wells are screened in the Upper Glacial aquifer but many are screened in the Magothy aquifer. VOC contamination was found in all five study areas, and this contamination was characterized as being widespread in three of these areas.

The probable source of the VOC contamination in four of the five study areas was identified as industrial areas near the LIRR tracks. A similar industrial area is present directly adjacent (west) to the LIRR tracks that also border the Syosset Landfill. In the Dvirka and Bartilucci study, the VOC contamination was found at highest concentrations, and most frequently, in the Upper Glacial aquifer, but VOCs were also observed deep in the Magothy (more than 500 feet below land surface). In the New Cassel Study Area, 17 of the 35 wells sampled had concentrations of VOCs exceeding the then current New York State guidelines for organic compounds in drinking water. The principal VOCs detected (i.e. at highest concentrations and frequencies) were 1,1,1-trichloroethane (TCA), PCE, and TCE. In the Garden City Park Study Area, nine of the 17 wells sampled had VOC concentrations exceeding the New York state guidelines with PCE and TCE as the principal VOCs. One well screened in the upper part of the Magothy Formation had total VOC concentrations of approximately 200 ug/L.



Included in the Dvirka and Bartilucci report is a discussion of regional groundwater quality and VOC contamination is described as fairly widespread in Nassau County and considered a major threat to the water supply. VOC data collected between 1976 and 1984 from 434 public supply wells and 437 monitoring wells screening the Upper Glacial, Magothy and Llyod aquifers were obtained by NCDH and included in a table in the Dvirka and Bartilucci report. This table has been reproduced by Geraghty & Miller and is included as Table A-1 (attached). According to this data, of the 434 public supply wells sampled for VOCs, 21 percent had concentrations of up to 10 ug/L, 8 percent had concentrations from 10 ug/L to 50 ug/L, and 3 percent had concentrations greater than 50 ug/L. Of the 437 monitoring wells sampled, 28 percent contained VOC concentrations of up to 10 ug/L, 19 percent contained VOCs at concentrations from 10 ug/L to 50 ug/L, and 18 percent contained VOC concentrations over 50 ug/L.

It was stated in the Dvirka and Bartilucci report "In addition to industrial and commercial waste disposal, an extensive investigation into the uses of toxic household products determined that unsewered residential areas may also be a significant source of organic contamination (i.e., VOCs) of groundwater." The residential area downgradient of the Syosset Landfill is a residential area that was recently sewered about 15 years ago after the landfill closed (Viscardi, pers. comm. 1994). According to the Town of Oyster Bay, the average population density of Syosset is 3,766 people per square mile, or 5.88 people per acre (Rufrano, pers. comm. 1994). The actual population density in the residential development downgradient of the landfill is likely more than 10 people per acre because there is virtually no open space and, based on site visits, the houses are built on quarter-acre lot sizes or less. Therefore, assuming conservatively that there are three houses per acre and four persons residing in each house, then the population density calculates to 12 people per acre.

Five areas of different land use on Long Island located near the regional groundwater divide (long-term sewered suburban, recently sewered suburban, unsewered suburban, agricultural, and undeveloped) were the subject of a recent U.S. Geological Survey (USGS) study to statistically relate shallow contaminant distribution to land use (Leamond and Haefner, et. al 1992). Fourteen of the 19 wells sampled in the recently sewered area (defined in the report as having had sewer



hookup beginning about 1980 or approximately 14 years ago) were found to contain VOCs. VOC detections occurred with the highest frequency in the recently sewered study area. The most commonly detected VOCs were TCA, TCE, and PCE with total concentrations ranging from 2 ug/L to more than 12,000 ug/L. In five of these wells, VOCs were detected at concentrations above 29 ug/L.

Another USGS paper (Cain, Helsel, and Ragone 1989) also evaluates the degradation of regional groundwater quality (especially VOCs) as a result of human activities. Data from studies in six different states, including one on Long Island, New York, were used in the evaluation. All the studies were designed to quantitatively relate human activities, expressed as land use, to regional groundwater quality. For the Long Island study, water-quality data from 903 wells screened in the Upper Glacial aquifer were evaluated. The most commonly detected VOCs were TCA (24 percent of wells sampled), PCE (20 percent of wells sampled), TCE (18 percent of wells sampled), chloroform (9 percent of wells sampled) and 1,2-dichloroethylene (5 percent of wells sampled). In commercial or industrial areas, TCE, TCA, and PCE were detected in about 40 percent of wells sampled, while in medium to high-density residential areas, 20 to 40 of the wells sampled contained these VOCs. By using a simple linear regression, the percentage of occurrence of two of the more commonly detected VOCs (TCA and TCE) in the groundwater in the Long Island study were related to population density. This relationship is graphically represented in Figure A-1 and clearly demonstrates a direct correspondence between the two parameters (i.e., as population density increase so does the frequency of detection of VOCs). For example, Figure A-1 shows that with a population density equivalent to Syosset (approximately 12 people per acre) TCA and TCE would be expected to be detected in approximately 50 percent of any group of wells sampled in this area.

In yet another NCDH study, from 1977 to 1986, 46 public supply wells were restricted from use because individual VOCs had been detected above the 1977 New York State Department of Health guideline of 50 ug/L (NCDH 1988). Most of these wells are located in an east-west band across central Nassau County, close to the regional groundwater divide (Proceedings 1993).



In summary, the Syosset Landfill is located adjacent to an industrial area near the LIRR tracks and also adjacent to a recently sewered, densely populated residential area, which is close to the regional groundwater divide in central Nassau County. The investigations cited above were conducted in a setting strikingly similar to Syosset Landfill and the results indicate a similar range in VOC concentrations as those detected at the landfill. Thus, the documented regional degradation of groundwater provides strong supporting evidence that the VOC contamination detected in the Syosset Landfill study area is consistent with the findings of these studies.

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Table A-1. Summary of VOC Data Collected From Public Supply Wells and Monitoring Wells in Nassau County (1976 TO 1984).

	Number of Wells Tested	Percentage of Wells with no Detected VOCs	Percentage of Wells with VOC Concentrations of Less than 10 ug/L for any Single VOC	Percentage of Wells with VOC Concentrations from 10 to 50 ug/L for any Single VOC	Percentage of Wells with VOC Concentrations Greater than 50 ug/L for any Single VOC
<u>Public Supply Wells</u>					
Upper Glacial Aquifer	43	53	30	7	9
Magothy Aquifer	348	69	20	9	2
Lloyd Aquifer	43	79	19	2	0
Subtotal	434	69	21	8	3
<u>Monitoring Wells</u>					
Upper Glacial Aquifer	283	29	31	24	15
Magothy Aquifer	142	44	22	11	23
Lloyd Aquifer	12	83	17	0	0
Subtotal	437	36	28	19	18
<u>Aquifer Composite Totals</u>					
Upper Glacial Aquifer	326	33	31	22	14
Magothy Aquifer	490	62	20	10	8
Lloyd Aquifer	55	80	18	2	0
TOTAL	871	52	24	14	10

VOCs: Volatile organic compounds.

Note: Percentage of wells with respective VOC concentrations was based on the maximum level of any single VOC which was detected in the last sample collected from each well.

This includes all wells (including abandoned wells) that were sampled for VOCs and benzene, toluene, and xylenes since 1976.

Source: Dvirka and Bartilucci Consulting Engineers (1986) and Nassau County Department of Health.

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ATTACHMENT B

FATE AND TRANSPORT OF CONTAMINANTS



ATTACHMENT B

FATE AND TRANSPORT OF CONTAMINANTS

This section evaluates the mechanisms that control the migration and fate of contaminants in the subsurface. In this section, potential routes of migration through the vadose and phreatic (saturated) zones of the Magothy aquifer are discussed, followed by descriptions of the physical, chemical, and biological processes that affect the fate and transport of contaminants. In addition, an initial analysis of exposure pathways is presented to provide insight on potential risks posed by the migration of VOCs.

POTENTIAL ROUTES OF MIGRATION

Generally, when contaminants are released at the surface or in the shallow subsurface, they may migrate vertically downward through the vadose, or unsaturated zone, until they reach the water table, which represents the upper surface of the phreatic, or saturated, zone. When dissolved contaminants reach the water table, groundwater flow dynamics will be the primary influence on their migration.

Vadose Zone

During precipitation events, rainfall percolates through the landfill and dissolves contaminants which then migrate vertically downward under the influence of gravity through the vadose zone. This contaminated water moves vertically downward through the vadose zone until the water-table zone is encountered. Near the Syosset Landfill, the vadose zone consists of the coarse sand deposits of the Upper Glacial Formation.

Phreatic Zone

In the Syosset Landfill study area, the phreatic zone (exclusive of the Raritan Formation which is not the subject of the study) consists of the Magothy aquifer, which is characterized as



having a relatively high permeability (approximately 50 feet per day), but lower permeability than the Upper Glacial aquifer (approximately 270 feet per day) (Franke and Cohen 1972). In the unconsolidated deposits of the Magothy aquifer, groundwater moves through the interstitial pores. Physical processes that affect the transport of dissolved contaminants in the phreatic zone are advection, dispersion, and diffusion. Chemical factors inherent to these processes will be discussed below (Characteristics and Behavior of Contaminants).

Advection

The process by which dissolved contaminants are transported by the bulk movement of flowing groundwater is known as advection. The path of migration for dissolved contaminants in groundwater near the landfill is therefore primarily in the direction of groundwater flow. As discussed in the Hydrogeology section, groundwater flow in the vicinity of the site is primarily downward and to the north.

Dispersion and Diffusion

Dispersion and diffusion are processes that spread dissolved constituents in groundwater. The spread of dissolved contaminants from the Syosset Landfill is generally due to dispersion. Dispersion is dependent on groundwater velocity and it usually occurs at much higher rates than diffusion, which is dependent on solute concentration gradients. Dispersion is a mixing process that occurs at the microscale because of the nonlinear movement (or tortuous path) of groundwater through the aquifer material. This nonlinear movement results from heterogeneities in hydraulic properties of the geologic materials, which cause contaminants to move faster through some parts of the saturated material than through others. The amount of dispersion varies with groundwater velocity and is greatest in the direction of groundwater flow. Thus, dispersion in directions transverse to flow is typically much less than dispersion in the direction of flow (Freeze and Cherry 1979). At the Syosset Landfill, the rate of groundwater flow is relatively slow in the horizontal direction (0.1 feet per day) because of the very flat horizontal hydraulic gradient; it is also slow in the vertical direction because the very low vertical



permeability (due to the presence of lower permeability clay stringers, lenses and layers) offsets the higher downward hydraulic gradient (as compared to the horizontal hydraulic gradient).

Concentration gradients are the driving mechanism for the diffusion of contaminants in groundwater. Diffusion in solutions is the process whereby ionic or molecular constituents move in the direction of their concentration gradients or from areas of high concentrations to areas of low or no concentrations. This process stops only when chemical equilibrium occurs (the concentration gradients become nonexistent). Typically, this process is significant only where groundwater velocities are extremely slow (not the case at the Syosset Landfill).

CHARACTERISTICS AND BEHAVIOR OF CONTAMINANTS

Natural processes that affect the migration of contaminants in soil/water systems are sorption, volatilization, and transformation.

Sorption

Sorption is a physical process that retards the migration of contaminants in the subsurface. Organic compounds, such as VOCs, tend to partition between the groundwater and any solid organic carbon present in the aquifer material, and inorganic compounds tend to partition between the groundwater and clay minerals. Sorption is the reversible attachment of contaminants to solids or colloids in the subsurface. The type of attachment and the rate of sorption is dependent upon the type of contaminants and the solid/colloid. Sorption is also dependent upon the amount of available surface area or sites on the solid/colloid surface to which the contaminants may sorb. Once all of the available sites have been utilized, no more sorption will occur.

The rate of contaminant sorption is also influenced by the amount of organic carbon or clay minerals that is in direct contact with groundwater as it migrates through the pore spaces of the aquifer. If the carbon or clay is bound within the aquifer matrix or occurs at "dead end" pore



spaces, then it will have little, if any, effect on the sorption of dissolved VOCs. In general, sorption can be a significant process in controlling the rate of migration of contaminants.

The mobility of an organic compound can be evaluated by examining its aqueous solubility and the log of the organic carbon partition coefficient ($\log K_{oc}$). Aqueous solubility is a measure of the amount of a compound that will dissolve in a unit volume of water; more soluble compounds are generally more mobile. The $\log K_{oc}$ is a measure of the relative affinity of a compound for an organic medium (organic carbon) versus an aqueous medium (water); the lower the $\log K_{oc}$, the more mobile the compound.

Volatilization

Volatilization is a process generally associated with organic compounds or ammonia and refers to the transfer of compounds from the dissolved phase to the gaseous (vapor) state. Volatilization is assessed by examining the Henry's law constant for each compound. A smaller value of the Henry's law constant correlates with a less volatile compound. In the vadose zone, VOCs and ammonia can partition into the vapor phase (volatilize) and be transported vertically and horizontally. VOCs and ammonia can also volatilize from the groundwater at the water table and migrate into the vadose zone in the vapor phase.

Transformation

Many of the VOCs detected in groundwater at the Syosset Landfill may represent breakdown products of other, more chlorinated VOC molecules. This breakdown, or transformation, can be biological or chemical (abiotic). Inorganic chemicals may also undergo transformation depending on the chemical composition of the porous media (aquifer material), the chemical composition of ambient groundwater, and the presence of microorganisms.

The chlorinated aliphatic VOCs (for example, trichloroethene, tetrachloroethylene, cis- and trans-1,2-dichloroethene, 1,1-dichloroethene, and 1,1-dichloroethane) are susceptible to biological



transformation, but the rate of transformation can be very slow, particularly for TCE. Microorganisms in the subsurface can transform chlorinated VOCs and inorganic chemicals by the processes of oxidation or reduction. This transformation results in the production of another VOC or a net loss of VOCs from the groundwater. Generally, chlorinated aliphatic VOCs are reduced sequentially by hydrogenolysis (replacement of chlorine atoms by hydrogen) under strictly anaerobic conditions (Bechtel Environmental, Inc. 1990). For example, TCA may be dechlorinated to 1,1-dichloroethane (1,1-DCA) and PCE may be sequentially dechlorinated to TCE and 1,2-dichloroethene. Reduction of chlorinated alkanes (for example, 1,1-DCA or TCA) can also involve the loss of two halogens (dihalo-elimination), resulting in conversion to an alkene. An example is the conversion of 1,2-dichloroethane to ethene (Vogel et al. 1987). Although hydrogenolysis occurs only under anaerobic conditions, dihalo-elimination can occur under either aerobic or anaerobic conditions. Bacteria can also oxidize some chlorinated compounds. For example, bacteria can transform TCE to biodegradable hydrolysis products (alcohols) in a methane-enriched groundwater environment (Henson, Yates et al. 1988).

Abiotic transformation mechanisms of significance to chlorinated aliphatics are substitution and dehydrohalogenation. Substitution reactions include hydrolysis, which produces an alcohol. An example of dehydrohalogenation is the conversion of TCA to 1,1-dichloroethene (Vogel et al. 1987). Abiotic transformations are generally much slower than biological transformations.

Transformation rates for VOCs and inorganic chemicals are typically estimated from laboratory or small-scale field experiments. Indirect evidence for transformation is obtained from the relative distributions of constituents. Concentration ratios (for VOCs for example, PCE:TCE) are often examined to determine whether transformation has occurred. Application of this technique is limited when there is more than one source location, when different commercial products of varying grades of purity may have been released, and when the site-specific contaminants migrate at significantly different rates because of different retardation factors (e.g., sorption rates). Nonetheless, it is important to recognize the potential for transformations to occur because transformation can have a significant overall effect on the migration of contaminants in the subsurface.



ANALYSIS OF EXPOSURE PATHWAYS

Because the Syosset Landfill capping program is in progress in accordance with 6 NYCRR Part 360, and based on the results of landfill gas monitoring that indicate that landfill gases have not migrated off-site, the only potential route of exposure is the groundwater. The nearest active public supply wells are owned by the Jericho Water District (N-198, which is screened from 566 to 616 feet below land surface, and N-199, which is screened from 544 to 600 feet below land surface). These wells are located approximately 2 miles downgradient (north) of the landfill. The contaminants of concern have been defined as those chemical constituents (VOCs) that were detected above MCLs in on-site and off-site monitoring wells during the OU-1 and OU-2 RIs. It is highly improbable that these VOCs, which are contained in the leachate plume derived from the Syosset Landfill, will reach public supply wells N-198 and N-199 at detectable concentrations, even assuming that these wells are within the groundwater flow path from the landfill. This analysis is based on the relatively low concentrations of these constituents, the distance of the wells from the landfill, and the mitigating effects of dispersion and biochemical processes discussed above. The risks posed by the contaminants of concern will be addressed in more detail in a future risk assessment report.

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ATTACHMENT C

POTENTIAL IMPACTS FROM RECHARGE BASIN



ATTACHMENT C

POTENTIAL IMPACTS FROM RECHARGE BASINS

LEACHATE INDICATOR PARAMETERS

The concentrations and distribution of leachate indicator parameters observed during the OU-2 RI in the on-site and off-site groundwater monitoring wells are consistent with a plume of impacted groundwater derived from the Syosset Landfill, that is moving downward, and extending off-site. This contaminant profile correlates well with the horizontal and vertical groundwater flow directions observed during the OU-2 RI. As stated in the Contaminant Distribution section (3.3) of the OU-2 RI, the concentrations of leachate indicator parameters detected in the on-site wells are similar to the concentrations detected in the deeper (intermediate) off-site wells. This similarity, therefore, lacks the variability in contaminant concentrations that would otherwise indicate a contribution of these constituents from another source, such as one of the stormwater basins near the site.

On Long Island, stormwater runoff, which is mainly from roads, comprises approximately 20 percent of the recharge to the underlying aquifers, and is collected in the more than 2,000 stormwater basins scattered throughout Nassau and Suffolk Counties (Long Island Regional Planning Board 1978). The potential impacts of stormwater runoff that collects in Long Island recharge basins was addressed in a major study conducted for the Long Island Regional Planning Board (LIRPB): Long Island Segment of the Nationwide Urban Runoff Program (LIRPB 1982). It was concluded in the 1982 LIRPB report that "with the exception of lead and chloride, the concentrations of inorganic chemicals measured in stormwater runoff do not have the potential to adversely affect groundwater quality" (LIRPB 1982).



VOCs

As discussed in Attachment A (Regional Background Groundwater Quality), except for Well RW-12I, the VOC concentrations detected in on-site and off-site monitoring wells are consistent with regionally degraded background groundwater quality conditions for an area with land use such as near the site.

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ATTACHMENT D

CONTAMINANTS OF CONCERN



Table D-1. Analytical Parameters which Exceeded Federal and/or State Maximum Contaminant Levels During the Second Operable Unit Remedial Investigation of the Syosset Landfill, Syosset, New York.

VOCs	Metals	Leachate Indicator Parameters
Vinyl chloride	Antimony	Chloride
1,1-Dichloroethene	Arsenic	Sulfate
1,1-Dichloroethane	Beryllium	Total Dissolved Solids
cis-1,2-Dichloroethene	Iron	
Chloroform	Lead	
1,1,1-Trichloroethane	Sodium	
Benzene	Zinc	
Trichloroethene		
Toluene		
Tetrachloroethene		
2-Hexanone		
Chlorobenzene		
Ortho-xylene		

VOCs Volatile organic compounds.

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ATTACHMENT E
CORRECTION FACTORS USED FOR GAMMA LOGS



ATTACHMENT E

CORRECTION FACTORS USED FOR GAMMA LOGS

During the OU-2 RI, two deep well borings (SY-3DD and PK-10D) were drilled by the air-rotary (Barber) method using steel casing. Due to the frictional resistance of drilling these borings to a depth of over 500 feet, several different casing diameters (16-inch, 10-inch, 8-inch, and 6-inch) were required to reach the termination depths of these two well borings. These casings are telescoped within each other with all the casing sizes present in the interval from land surface to the termination depth of the largest casing size (16-inch diameter). When the final depth of each boring was reached (540 feet for Well Boring SY-3DD and 500 feet for PK-10D), only the smallest casing size remained (6-inch diameter casing for Well Boring SY-3DD and 8-inch diameter casing for Well Boring PK-10D). Each well boring was then logged by the natural gamma method using an EG&G Mount Sopris Model II logging system. Mount Sopris, Inc., the manufacturer of the logging system, is owned by Colog, Inc. (Colog), and both companies are located in Golden, Colorado.

According to Colog, steel casing dampens the gamma log response in direct proportion to the wall thickness of the casing. Borehole diameter also dampens the gamma log response (in direct proportion to the diameter), but to a much lesser degree. Adjustments are not routinely made to correct for either casing or borehole diameter interferences, especially when these factors are constant for the depth of the borehole. However, because these factors were not constant due to the telescoped casings, a correction factor was developed for the casing interferences. A correction factor was not used for the borehole diameter because, as noted above, the dampening effect on the gamma log response is not significant for this parameter. According to Colog, computer models have been run by Mount Sopris to quantify correction factors for gamma logs run inside of steel casings of varying thicknesses. Colog informed Geraghty & Miller that computer modeling has also been performed by Mount Sopris to determine correction factors for telescoped casings, and if the telescoped casings are close in diameter (i.e., with less than 2-inches of annular space), then they can be regarded as a single casing. Thus, the composite thickness, which is equivalent to the sum of the thicknesses of each individual casing, was then



used to obtain the corresponding correction factor from the attached graph (Figure E-1). A summary of the factors that were used for each interval of telescoped steel casing to correct the gamma logs run in Well Borings SY-3DD and PK-10D is presented in Table E-1. Once the correction factor was determined, it was used as a multiplication factor for the gamma radiation count rate to calculate the adjusted natural gamma log response depicted on Figures 3-1 and 3-2 in the OU-2 RI report.

No correction factor was provided for the depth interval of each well boring that included the 16-inch diameter casing because the annular space between this casing and the next smaller diameter casing (10-inch) is too large (i.e., 4 inches). An annular space of this size causes too many attenuations because the gamma waves cannot penetrate the inner casing (10-inch) properly after penetrating the outer casing (16-inch) and travelling through the annular space. Because the 16-inch diameter casing was used to case off the rather coarse and homogeneous deposits of the Upper Glacial aquifer, the missing data from this zone was not an important factor in preparing hydrogeologic cross sections.

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Table E-1. Correction Factors Used for Well Casing Interferences for Gamma Logs of Well Borings SY-3DD and PK-10D.

Well Boring Number	Depth Interval (ft bls)	Casings Present per Depth Interval (diameter in inches)	Composite Casing Thickness ^(a) (inches)	Correction Factor
SY-3DD	0 - 118	6, 8, 10, 16	1.342	(b)
	118 - 318	6, 8, 10	0.967	3.52
	318 - 462	6, 8	0.602	2.50
	462 - 540	6	0.280	1.62
PK-10D	0 - 118	8, 10, 16	1.062	(b)
	118 - 460	8, 10	0.687	2.75
	460 - 500	8	0.322	1.74

ft bls Feet below land surface.

- (a) According to the firm that drilled the well borings, Delta Well and Pump Company, Inc., the thickness of the 16-inch diameter casing, 10-inch diameter casing, 8-inch diameter casing, and 6-inch diameter casing are 0.375 inches, 0.365 inches, 0.322 inches and 0.280 inches, respectively.
- (b) No correction factor was provided for the depth interval that included the 16-inch diameter casing in each well boring because the annular space between this casing and the next smaller diameter casing (10-inch) is too large. An annular space of this size causes too many attenuations because the gamma waves cannot penetrate the inner casing (10-inch) properly after penetrating the outer casing (16-inch) and travelling through the annular space.

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ATTACHMENT F

REVISED TABLE OF NASSAU COUNTY WELLS



Table 2-4. Summary of Water-Level Elevation Data Collected on October 29, 1993 from Nassau County Monitoring Wells Within Approximately 2 Miles of the Syosset Landfill During the Second Operable Unit Remedial Investigation, Syosset, New York.

Well Number	NYSDEC Well Number	Total Depth (feet below land surface)	Total Depth (feet below water level)	Elevation of Measuring Point (a) (feet above mean sea level)	Depth to Water (feet below measuring point)	Water-Level Elevation (feet above mean sea level)
O-6A	N9353	101.05	36.78	140.42	64.27	76.15
O-7A	N9050	175.50	—	228.24	(b)	(b)
O-8	N1194	104.10	16.65	167.98	87.45	80.53
O-9	N1195	116.35	44.69	148.30	71.66	76.64
OP-1	N9926	129.90	43.33	168.18	86.57	81.61
OP-2	N9928	40.90	16.02	145.21	24.88 (c)	120.33
OP-3	N9927	94.20	8.82	161.68	85.38	76.30
P-7A	N10605	148.00	40.56	187.86	107.44	80.42
P-8A	N8888	111.20	16.20	174.49	95.00	79.49
P-9B	N9920	89.20	17.48	145.95	71.72	74.23
PT-1A	N10604	139.50	31.93	190.18	107.57	82.61
PT-2	N9933	114.65	15.11	178.97	98.94	80.03
PT-3	N9981	108.40	19.79	165.66	88.61	77.05
PT-4	N9932	104.80	31.38	145.54	73.42	72.12
T-5	N1228	175.90	11.08	227.12	164.82	62.30
T-6A	N10608	203.00	38.04	238.68	164.96	73.72
T-8	N1231	81.40	16.40	138.95	65.00	73.95
TU-1	N9934	126.50	30.20	173.93	96.30	77.63

(a) All wells are constructed at grade with a curb box assembly.

(b) Not recorded.

(c) Water level is anomalously high and was not used to contour the potentiometric surface map (Figure 3-3); well screen is likely plugged.



ATTACHMENT G

SUMMARY OF HORIZONTAL HYDRAULIC GRADIENT DATA



Table 3-1. Summary of Horizontal Hydraulic Gradient Data for Shallow, Intermediate, and Deep Hydrogeologic Zones, Based on Potentiometric Surface Maps (Figures 3-4 to 3-9).

Zone	Length of Groundwater Flow Line (L), in Inches, between Groundwater Elevation Contours ^(a)	Actual Distance (L), in Feet, between Groundwater Elevation Contours ^(a)	Change in Hydraulic Head (Δh) between Groundwater Elevation Contours, in Feet	Horizontal Hydraulic Gradient $I_H = \frac{\Delta H}{L}$ (Dimensionless)	Average I_H
Shallow					
Figure 3-4 (October 28, 1993)	4.8	1,440	1.0	0.00069	0.00065
	5.6	1,680	1.0	0.00060	
	5.0	1,500	1.0	0.00067	
Figure 3-5 (November 24, 1993)	4.8	1,440	1.0	0.00069	0.00064
	6.1	1,830	1.0	0.00055	
	4.8	1,440	1.0	0.00069	
Overall Average $I_{H \text{ Shallow}}$					0.00065
Intermediate					
Figure 3-6 (October 28, 1993)	1.2	360	0.5	0.00139	0.00114
	5.7	1,710	1.5	0.00088	
	4.4	1,320	1.5	0.00114	
Figure 3-7 (November 24, 1993)	1.2	360	0.5	0.00139	0.00108
	6.7	2,010	1.5	0.00075	
	4.6	1,380	1.5	0.00109	
Overall Average $I_{H \text{ Intermediate}}$					0.00111

Table 3-1. Summary of Horizontal Hydraulic Gradient Data for Shallow, Intermediate, and Deep Hydrogeologic Zones, Based on Potentiometric Surface Maps (Figures 3-4 to 3-9).

Zone	Length of Groundwater Flow Line (L), in Inches, between Groundwater Elevation Contours ^(a)	Actual Distance (L), in Feet, between Groundwater Elevation Contours ^(a)	Change in Hydraulic Head (Δh) between Groundwater Elevation Contours, in Feet	Horizontal Hydraulic Gradient $I_H = \frac{\Delta H}{L}$ (Dimensionless)	Average I_H
Deep					
Figure 3-8 (October 28, 1993)	2.2	660	0.44	0.00067	
Figure 3-9 (November 24, 1993)	2.2	660	0.56	0.00085	
				Overall Average $I_{H \text{ Deep}}$	0.00076

(a) The length of the groundwater flow lines in Figures 3-4 to 3-9 was determined by measuring the length of individual flow arrows between two groundwater elevation contours in inches with a ruler. The actual length (in feet) was calculated by multiplying the measured length in inches by the map scale (1 inch = 300 feet). Flow line lengths were measured in the order from west to east with the values shown on this table corresponding to this order from top to bottom.

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